WHAT IS CLAIMED IS:

1. An illumination apparatus comprising:

an inner-surface reflecting type integrator;

an optical system for directing a beam from a light source to a portion of incidence of said inner-surface reflecting type integrator;

an wave-front splitting type integrator;

an image-forming optical system for arranging the portion of incidence of said inner-surface reflecting type integrator approximately conjugate with a portion of incidence of said wave-front splitting type integrator, and for directing a beam from said beam mixer to said wave-front splitting type integrator; and

an irradiating optical system for superimposing multiple beams from said wave-front splitting type integrator on a plane to be irradiated, wherein a stop is provided at or near the portion of exit of said inner-surface reflecting type integrator.

2. An illumination apparatus according to claim 1, wherein said inner-surface reflecting optical integrator reflects at least a part of incident light with an internal surface of said inner-surface reflecting optical integrator, and for forming a surface light source on or near the plane of exit of said inner-surface reflecting optical integrator.

3. An illumination apparatus according to claim 1, wherein said wave-front splitting type integrator is a lens array for splitting a wave front of incident light, and for forming multiple secondary light sources on or near the portion of exit of said wave-front splitting type integrator.

4. An illumination apparatus according to claim 1, wherein said stop is a mechanical aperture stop.

5. An illumination apparatus according to claim 1, wherein said stop is made of a light shielding material applied onto the portion of exit of said inner-surface reflecting type integrator.

6. An illumination apparatus according to claim 1, wherein said stop is made of a multi-layer film vapor-deposited onto the portion of exit of said inner-surface reflecting type integrator.

7. An illumination apparatus according to claim 1, wherein said stop is made of a metallic film vapor-deposited onto the portion of exit of said inner-surface reflecting type integrator.

8. An illumination apparatus according to claim 1-7, wherein said image-forming system is a zoom optical system.

9. An illumination apparatus according to claim 1 or 8, wherein the portion of exit of said inner-surface reflecting type integrator has a polygonal shape, and said stop has an aperture for correcting σ anisotropy.

10. An illumination apparatus according to claim 9, wherein said stop has an approximately circular aperture.

11. An illumination apparatus according to claim 9, wherein said stop has apertures having an approximately equal diameter at least in four directions of 0°, 45°, 90°, and 135°.

12. An illumination apparatus comprising;

an inner-surface reflecting type integrator including a portion of exit with an n-gonal shape where n is a natural number;

a wave-front splitting type integrator;

a zoom optical system for projecting an image of the portion of exit of said inner-surface reflecting type integrator, onto a portion of incidence of said wave-front splitting integrator; and

an irradiating optical system for superimposing multiple beams from said wave-front splitting integrator on a plane to be irradiated, wherein a stop having an approximately circular aperture is provided at or near the portion of exit of said inner-surface reflecting type integrator.

13. An illumination apparatus comprising:

an inner-surface reflecting type integrator including a portion of exit with a n-gonal shape where n is a natural number;

a first condensing optical system for condensing a beam from a light source near a portion of incidence of said inner-surface reflecting type integrator;

a wave-front splitting type integrator;

a zoom optical system for projecting an image of the portion of exit of said inner-surface reflecting integrator, onto a portion of incidence of said wave-front splitting type integrator; and

a second condensing optical system for condensing a beam from an irradiating optical system for superimposing multiple beams from said wave-front splitting type integrator on a plane to be irradiated, wherein there is provided a stop having an aperture with an approximately 2n-gonal shape where n is a natural number at or near a portion of incidence of said inner-surface reflecting type integrator.

14. A projection exposure apparatus comprising:

an illumination apparatus for illuminating a mask located on a plane to be illuminated; and

a projection optical system for projecting a pattern on said mask onto a wafer,

wherein said illumination apparatus comprising:

an inner-surface reflecting type integrator;

an optical system for directing a beam from a light source to a portion of incidence of said inner-surface reflecting type integrator;

an wave-front splitting type integrator;

an image-forming optical system for arranging the portion of incidence of said inner-surface reflecting type integrator approximately conjugate with a portion of incidence of said wave-front splitting type integrator, and for directing a beam from said beam mixer to said wave-front splitting type integrator; and

an irradiating optical system for superimposing multiple beams from said wave-front splitting type integrator on a plane to be irradiated, wherein

a stop is provided at or near the portion of exit of said inner-surface reflecting type integrator.

15. A projection exposure apparatus comprising:

an illumination apparatus for illuminating a mask located on a portion to be illuminated; and

a projection optical system for projecting a pattern on said mask onto a wafer,

wherein said illumination apparatus comprising:

an inner-surface reflecting type integrator including a portion of exit with an n-gonal shape where n is a natural number;

a wave-front splitting type integrator;

a zoom optical system for projecting an image of the portion of exit of said inner-surface reflecting type integrator, onto a portion of incidence of said wave-front splitting integrator; and

an irradiating optical system for superimposing multiple beams from said wave-front splitting integrator on a plane to be irradiated, wherein a stop having an approximately circular aperture is provided at or near the portion of exit of said inner-surface reflecting type integrator.

16. A projection exposure apparatus comprising:

an illumination apparatus for illuminating a mask located on a portion to be illuminated; and

a projection optical system for projecting a pattern on said mask onto a wafer,

wherein said illumination apparatus comprising:

an inner-surface reflecting type integrator including a portion of exit with a n-gonal shape where n is a natural number;

a first condensing optical system for condensing a beam from a light source near a portion of incidence of said inner-surface reflecting type integrator;

a wave-front splitting type integrator;

a zoom optical system for projecting an image of the portion of exit of said inner-surface reflecting integrator, onto a portion of incidence of said wave-front splitting type integrator; and

a second condensing optical system for condensing a beam from an irradiating optical system for superimposing multiple beams from said wave-front splitting type integrator on a plane to be irradiated, wherein there is provided a stop having an aperture with an approximately 2n-gonal shape where n is a natural number at or near a portion of incidence of said inner-surface reflecting type integrator.

17. A device fabrication method comprising the steps of:

projecting a pattern on a mask onto a wafer by using a projection exposure apparatus; and

developing said wafer to which said pattern was transferred,

wherein said projection exposure apparatus comprising:

an illumination apparatus for illuminating a mask located on a plane to be illuminated; and

a projection optical system for projecting a pattern on said mask onto a wafer,

wherein said illumination apparatus comprising:

an inner-surface reflecting type integrator;

an optical system for directing a beam from a light source to a portion of incidence of said inner-surface reflecting type integrator;

an wave-front splitting type integrator;

an image-forming optical system for arranging the portion of incidence of said inner-surface reflecting type integrator approximately conjugate with a portion of incidence of said wave-front splitting type integrator, and for directing a beam from said beam mixer to said wave-front splitting type integrator; and

an irradiating optical system for superimposing multiple beams from said wave-front splitting type integrator on a plane to be irradiated, wherein

a stop is provided at or near the portion of exit of said inner-surface reflecting type integrator.

18. A device fabrication method comprising the steps of:

projecting a pattern on a mask onto a wafer by using a projection exposure apparatus; and

developing said wafer to which said pattern was transferred,

wherein said projection exposure apparatus comprising:

an illumination apparatus for illuminating a mask located on a plane to be illuminated; and

a projection optical system for projecting a pattern on said mask onto a wafer,

wherein said illumination apparatus comprising:

an inner-surface reflecting type integrator including a portion of exit with an n-gonal shape where n is a natural number;

a wave-front splitting type integrator;

a zoom optical system for projecting an image of the portion of exit of said inner-surface reflecting type integrator, onto a portion of incidence of said wave-front splitting integrator; and

an irradiating optical system for superimposing multiple beams from said wave-front splitting integrator on a plane to be irradiated, wherein a stop having an approximately circular aperture is provided at or near the portion of exit of said inner-surface reflecting type integrator.

19. A device fabrication method comprising the steps of:

projecting a pattern on a mask onto a wafer by using a projection exposure apparatus; and

developing said wafer to which said pattern was transferred,

wherein said projection exposure apparatus comprising:

an illumination apparatus for illuminating a mask located on a plane to be illuminated; and

a projection optical system for projecting a pattern on said mask onto a wafer,

wherein said illumination apparatus comprising:

an inner-surface reflecting type integrator including a portion of exit with a n-gonal shape where n is a natural number;

a first condensing optical system for condensing a beam from a light source near a portion of incidence of said inner-surface reflecting type integrator;

a wave-front splitting type integrator;

a zoom optical system for projecting an image of the portion of exit of said inner-surface reflecting integrator, onto a portion of incidence of said wave-front splitting type integrator; and

a second condensing optical system for condensing a beam from an irradiating optical system for superimposing multiple beams from said wave-front splitting type integrator on a plane to be irradiated, wherein there is provided a stop having an aperture with an approximately 2n-gonal shape where n is a natural number at or near a portion of incidence of said inner-surface reflecting type integrator.